\[ \frac{\partial L}{\partial t} = \sum_{i} \frac{\partial \dot{u}}{\partial \dot{u}} \ddot{u} + \sum_{i} \frac{\partial \ddot{u}}{\partial \ddot{u}} \dddot{u} \]

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\[ \Rightarrow \frac{\partial L}{\partial t} - \sum_{i} \frac{\partial \ddot{u}}{\partial \ddot{u}} \dddot{u} = 0 \]

\[ \text{Energy} \quad E = \sum_{i} \frac{\partial \ddot{u}}{\partial \ddot{u}} \dddot{u} - T \]

\[ \text{Conservative systems: mechanical systems} \]

\[ \text{for which the energy is conserved} \]

\[ L = T - U \]

\[ T \text{ is a quadratic function of velocity} \]

\[ \Rightarrow \sum_{i} \ddot{u} \frac{\partial L}{\partial \ddot{u}} = \sum_{i} \ddot{u} \frac{\partial T}{\partial \ddot{u}} = 2T \]

\[ \Rightarrow E = 2T - T + U = T + U \]

\[ \text{of cartesian} \quad E = \sum_{i} \frac{1}{2} m \dot{x}^2 + U(q_1, q_2) \]